Preface

Water is considered as "the life line" for every living organism. Pollution of water by various hazardous elements causes serious ill-effects on human as well as other living organisms. Safe water is currently a great concern in front of human being.

Arsenic, iron, manganese, and some other heavy metals such as lead, cadmium, nickel, chromium, copper, cobalt, mercury, etc., are common contaminates found in groundwater as well as surface water originating from some geological and anthropogenic activities. It is creating jeopardy worldwide as a long-time exposure of these contaminants in drinking water can cause severe health problems including cancer. Therefore, removal of hazardous heavy metals from groundwater has a prime importance in the context of water purification.

Various conventional and advanced water treatment methods have been developed for removal of arsenic, iron and other heavy metals from groundwater. However still an efficient, low-cost and easy operational methods for removal of heavy metals like arsenic, iron, manganese, and other heavy metals, is rare. Coagulation-precipitation is one of the most cost-effective and efficient methods for removal of arsenic, iron and some heavy metals. One such coagulation-precipitation method, known as 'Oxidation-coagulation at optimized pH (OCOP)' method, was developed recently at Tezpur University. The OCOP method, which uses $NaHCO_3$, $KMnO_4$, *and* $FeCl_3$ *as pH conditioner, oxidant and coagulant, respectively, is a very efficient and cost-effective method which can removes arsenic and iron simultaneously from groundwater. The method, popularly known as Arsiron Nilogon method has been gaining popularity, especially in Asam and is already being used by tens of thousands of arsenic-affected people. The present research work is focused on this OCOP method to modify it to make it more efficient, more cost effective.*

Coexisting iron in groundwater helps in removal of arsenic because coexisting iron itself forms coagulates such as FeOOH, Fe_2O_3, $Fe(OH)_3$, *etc., which are good adsorbents of arsenic. It was expected to be beneficial for the treatment of arsenic contaminated groundwater that usually contains excess of dissolved ferrous iron by the OCOP method. We used coexisting iron instead of externally added* $FeCl_3$ *or minimum amount of* $FeCl_3$ *as possible to lower the cost of the OCOP method and finally we achieved some good results on arsenic removal from contaminated groundwater with lower cost than the original OCOP method.*

In Assam groundwater of some arsenic contaminated areas also contains manganese as dissolved element. So, we used OCOP method to remove manganese along with arsenic and iron and also achieved good results.

Use of various oxidants for oxidation of As^{3+} *have been reported in the literature including potassium permanganate, ozone, hydrogen peroxide, chlorine, ferrate, Fenton's reagent, hypochlorite, etc. However, a comparative study of the most potential oxidants for the purpose was lacking. Therefore, a comparative study of the performances of the commonly used oxidants such as* $KMnO_4$, H_2O_2, *NaOCl, and Fenton's reagent in the OCOP method has been carried out. The laboratory experiments show that* $KMnO_4$ *has better performance in OCOP method on oxidation of hardly removable* As^{3+} *to easily removable* As^{5+} *which finally gave best results on removal of arsenic among all chosen oxidants followed by Fenton's reagent.*

Though the OCOP method has capability to remove other heavy metals it was not systematically studied in laboratory to remove heavy metals other than arsenic and iron. It has also been noted that rarely all common heavy metals are removed by a single process. So, in this work the OCOP method was tried to remove heavy metals such as lead, cadmium, chromium, nickel, copper, and cobalt from synthetically contaminated water with variation of initial metal concentration and residential time. The removal of the heavy metals from equal initial concentration of 2 mg/L was found to increase in the order Cd (79.0%) << Co (94.8%) < Ni (94.4%) << Cu (98.0%) < Cr (98.3%) < Pb (99.5%).

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